

Title: Protection of Groundwater Quality near Geothermal Energy Systems

Abstract: Thermal energy of groundwater can be used as a source of energy for both heating and cooling. In an open loop geothermal energy system, groundwater is extracted from the subsurface in one location and circulated through a heat pump, and then the water is reinjected into the subsurface at a downstream location. The groundwater temperature remains relatively constant throughout the year. During the summer, the open loop system is used for cooling while the outside air temperature is above the groundwater temperature. The groundwater absorbs heat as it is circulated through the heat pump, so the reinjected groundwater is warmer than the aquifer. During the winter, the groundwater is warmer than the air temperature, so it loses heat in the heat pump, and the reinjected water is cooler than the aquifer. Thus, a thermal plume of either warmer water or cooler water emanates from the reinjection well and travels downstream. The change in temperature of the downstream groundwater may negatively impact the downstream users and receptors. In this work, we use adjoint modeling of the thermal plume to identify allowable locations of the open loop geothermal energy systems such that groundwater temperature changes induced by the system remain below allowable thresholds where groundwater discharges into temperature-sensitive ecosystems.